Table 1. Assumptions considered by NMFS (grouped from optimistic to pessimistic) and used (shaded) in the draft 2000 Biological Opinion for action agencies' responsibility to achieve survival and recovery of listed Snake River spring/summer chinook salmon. Recommended assumptions are presented in column on right.

| Factors affecting estimated needed survival improvements		Assumptions considered by NMFS				Recommended
		optimistic	-------------------->	pessimistic		
Extinction Standard		<1 fish/generation	<90% decline	<50% decline		VSP or BRWG thresholds
Recovery Standard		100 yr	48 yr	24 yr		24 yr and 48 yr
FCRPS Survival Performance Standard		no delayed mort		hydrosystem delayed mort		hydrosystem delayed mortality
Definition of High Risk		<5% prob		<1% prob		
Hatchery Effectiveness		0%	20%	80%	100%	stock specific (for SR spr/sum use 80%)
Population behavior (low pop.)		density dependence w/o depensation	density independence	density dependence (with depensation)		density dependence (w/ depensation)
Population behavior (high pop.)		density independence		density dependence		density dependence
Time Series		1980-2004	1980-present	1990-present		1970-present
Population growth rate		linear		non-linear (declining rate)		account for non-linearity
Factors affecting expected improvement: action & RPA						
Increase juvenile survival from 1995 BiOp		due to hydrosystem improvements	due to model differences	due to flow		use same flow dependent models
Adult survival		7% increase		0% increase		support assumption, else 0%
Survival improvements from						
hatcheries		meets needed improvement	feasible improvements	no improvements		model feasible improvements
habitat		meets needed improvement	feasible improvements	no improvements		model feasible improvements
harvest		meets needed improvement	feasible improvements	no improvements		model feasible improvements
			= Assumptions chosen by NMFS for action agencies responsibility to achieve			
			survival and recovery			
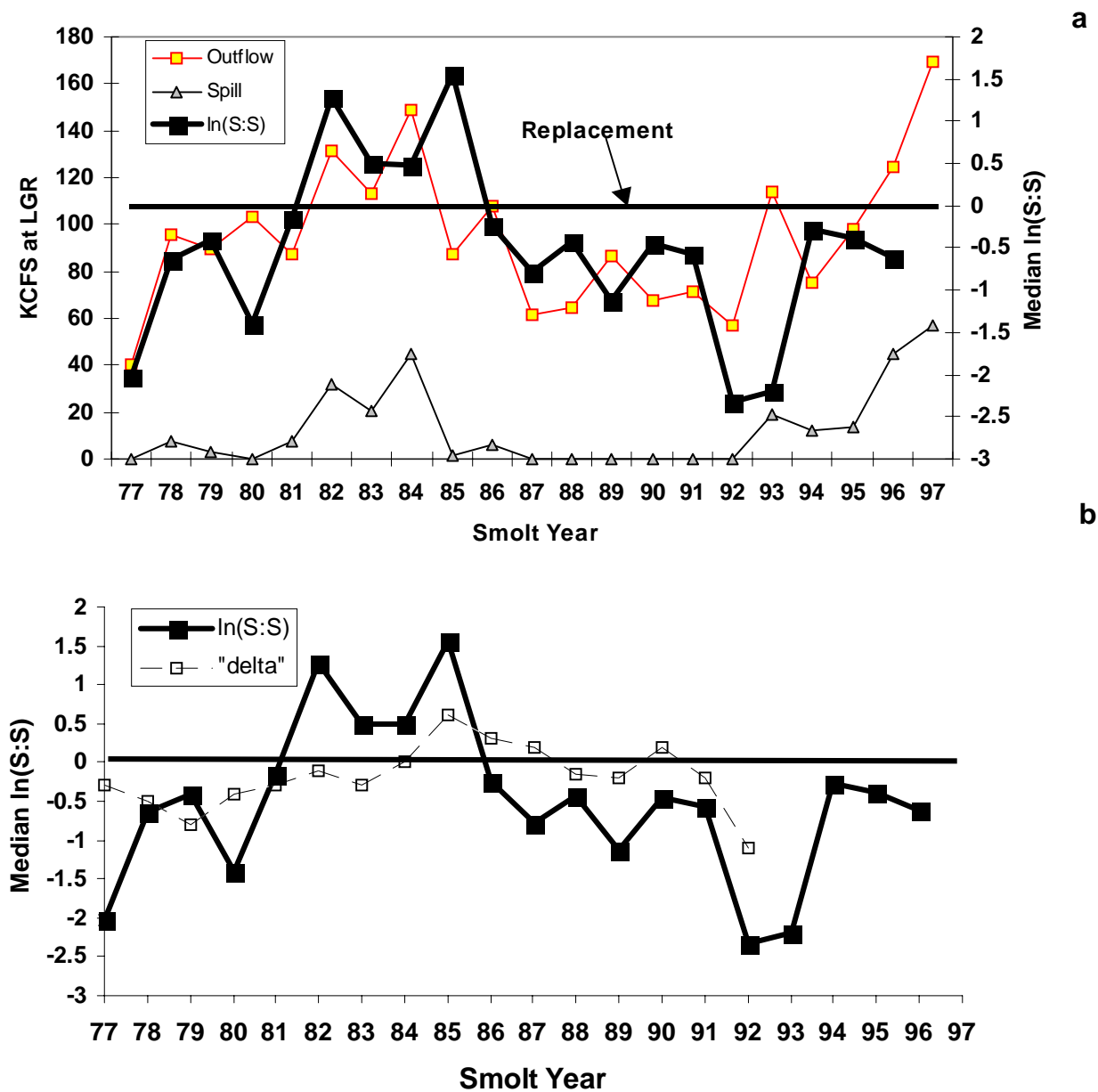
Figure 1. (a): Natural log of ratio of recruits to spawning grounds divided by parent spawners (ln(S:S)) for seven index stocks of Snake River spring/summer chinook used in PATH compared to average flow and spill at Lower Granite Dam (kcfs at LGR) experienced during the springtime smolt migration, 1977-1996. The populations increase when ln(S:S) > 0 and decrease when ln(S:S) < 0. (b): Natural log of ratio of recruits to spawning grounds divided by parent spawners (ln(S:S)) for Snake River index stocks compared to the common year effect "delta" estimated in PATH for upriver and downriver stream-type chinook salmon (Deriso et al. 1996), smolt years 1977-1992.

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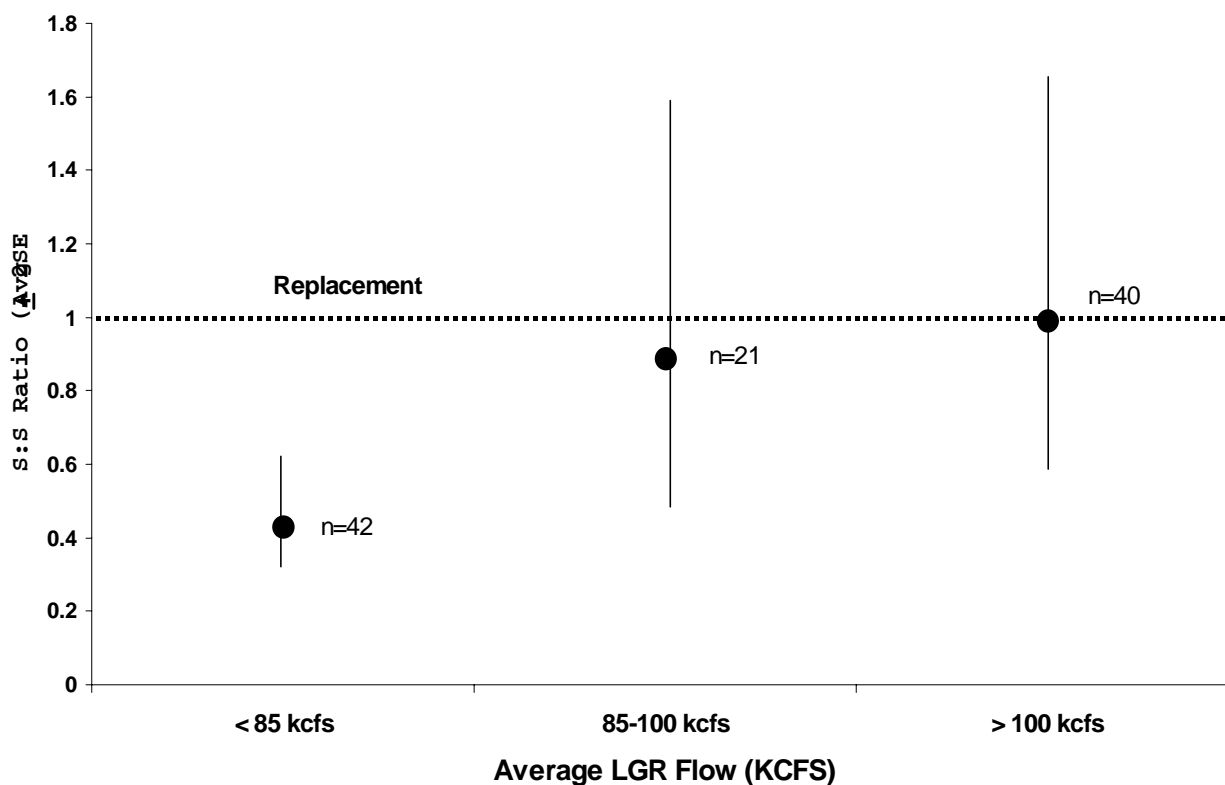## Spawner:Spawner Ratios, Brood Years 1980-94

Figure 2. Average spawner to spawner ratio $\pm$ 2SE (natural log transformation) for seven index stocks of Snake River spring/summer chinook, brood years 1980-1994 (smolt years 1982-1996), compared to average springtime flow categories at Lower Granite Dam (LGR). 1995 BiOp flow targets are 85-100 kcfs, which are associated with returns averaging less than replacement. The populations increase when S:S > 1 and decrease when S:S < 1. Sample sizes (n) represent years and individual stocks combined.
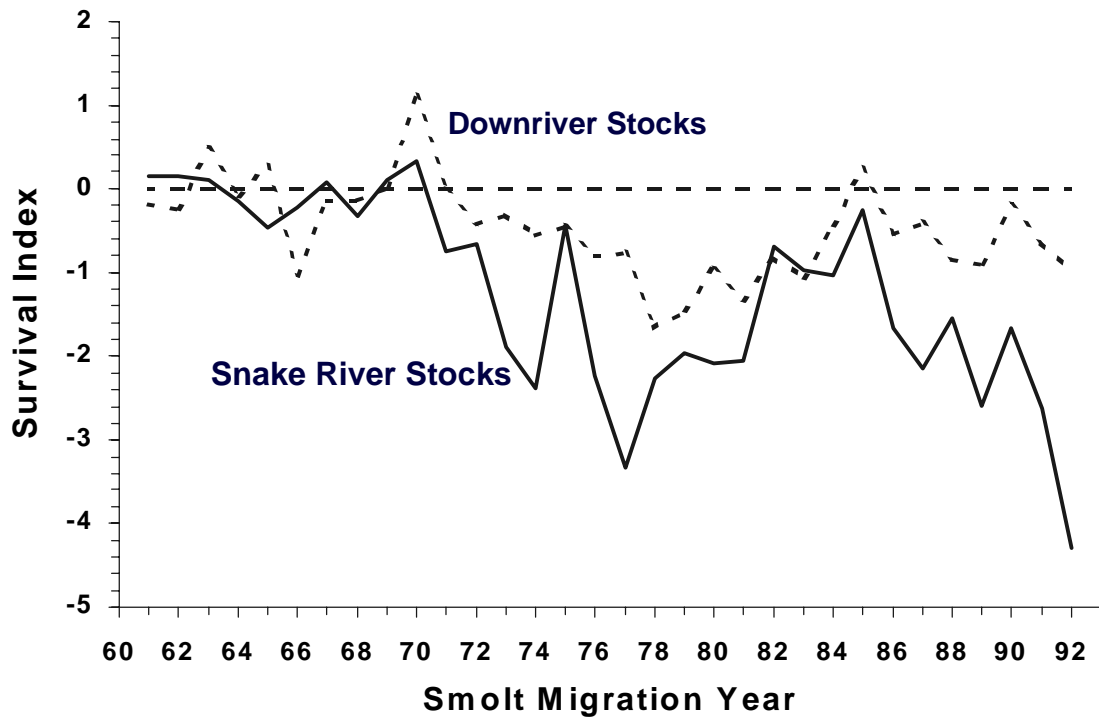
Spring/Summer Chinook

Figure 3. Survival rate index comparisons for Snake River spring/summer chinook and lower Columbia River spring chinook (stream-type), brood years 1959-1990. Survival index values of 0, -1, -2 and –3, represent relative survival of 100%, 37%, 14% and 5% that of the pre-1970 era. Source: Schaller et al. 1999.
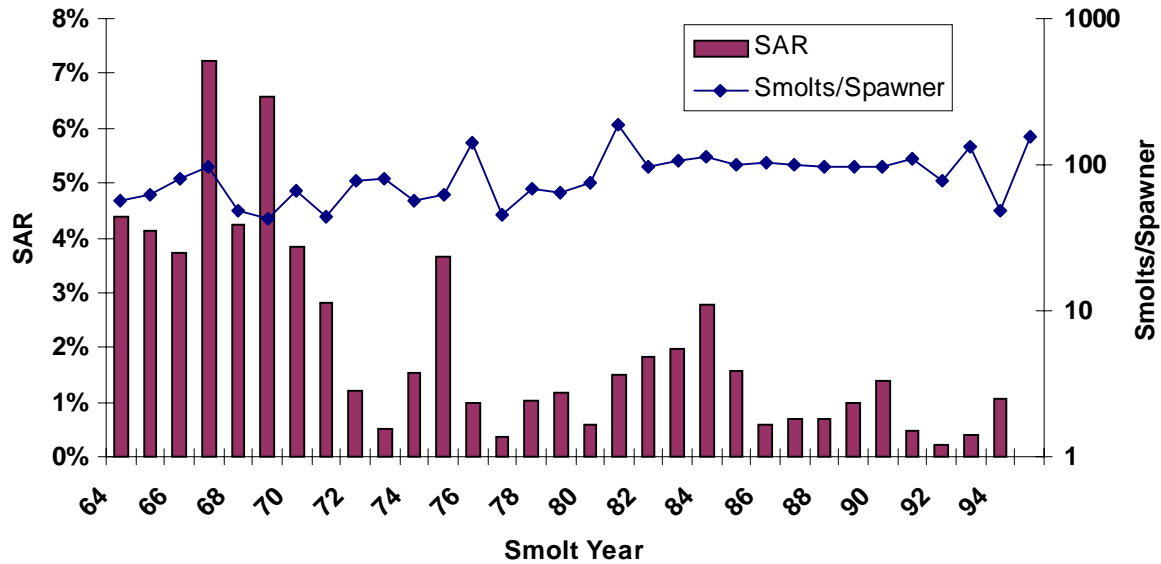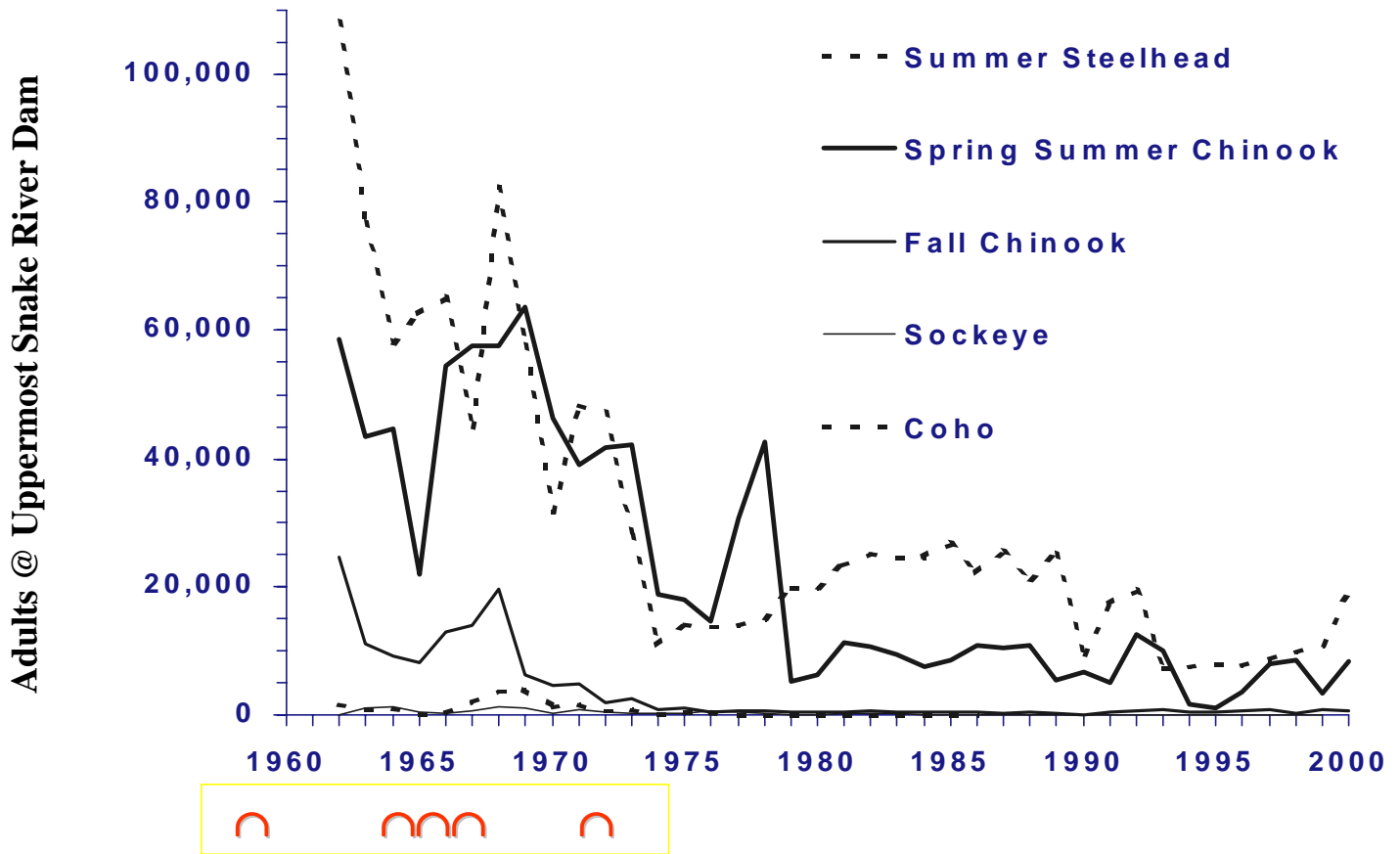
SAR vs. Smolts/Spawner

Figure 4. Smolt-to-adult return rate (SAR) and smolts per spawner (log scale) for wild Snake River spring/summer chinook, 1964-1994 migration years. Estimates for 1984-1990 based on predicted wild smolt yield from PATH retrospective analyses. Source: STUFA 2000.

Figure 5. Number of wild summer steelhead spring/summer chinook, fall chinook, sockeye, and coho salmon returning the Snake River, 1960-1999. Years of dam completion were Ice Harbor (IHR)-1962; John Day (JDA)-1968; Lower Monumental (LMN)-1969; Little Goose (LGO)-1970; and Lower Granite (LGR)-1975.
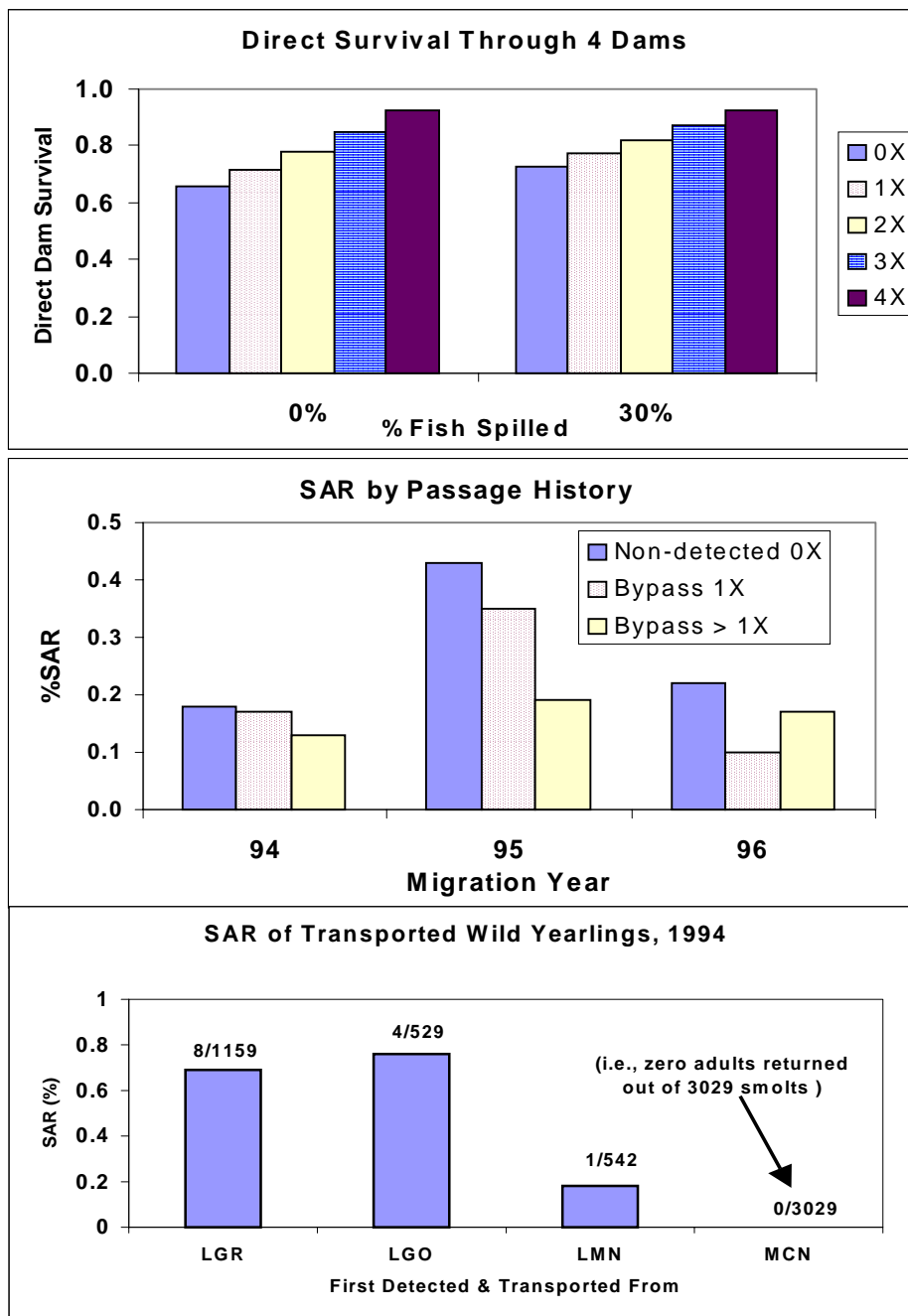
Figure 6. A. Direct dam passage survival through four dams for undetected smolts (0X), and those detected/bypassed 1, 2, 3,and 4 times (1X-4X). B. Percent smolt-to-adult return rate (SAR) for undetected smolts, and those bypassed one time (1X) and more than one time (>1X). C. SAR of transported smolts that were first collected (detected) at four dams: Lower Granite (LGR), Little Goose (LGO), Lower Monumental (LMO), and McNary (MCN), 1994.
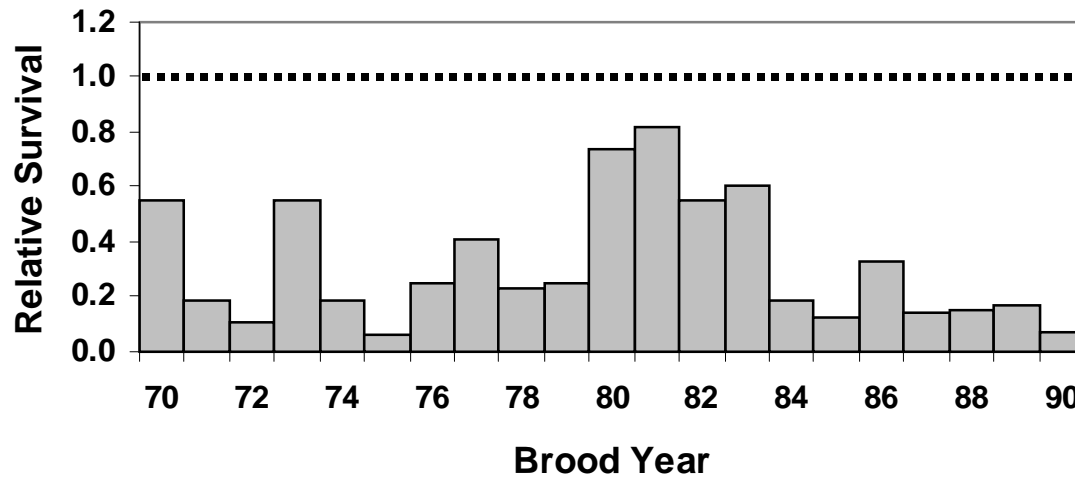
Snake River Wild Spring-Summer Chinook

Figure 7. Relative survival ($e^{-\mu}$) of Snake River spring/summer chinook compared to downriver stocks, brood years 1970-1990 (adapted from Deriso et al. 1996). A value of 1.0 indicates Snake River stocks survived as well as downriver stocks.
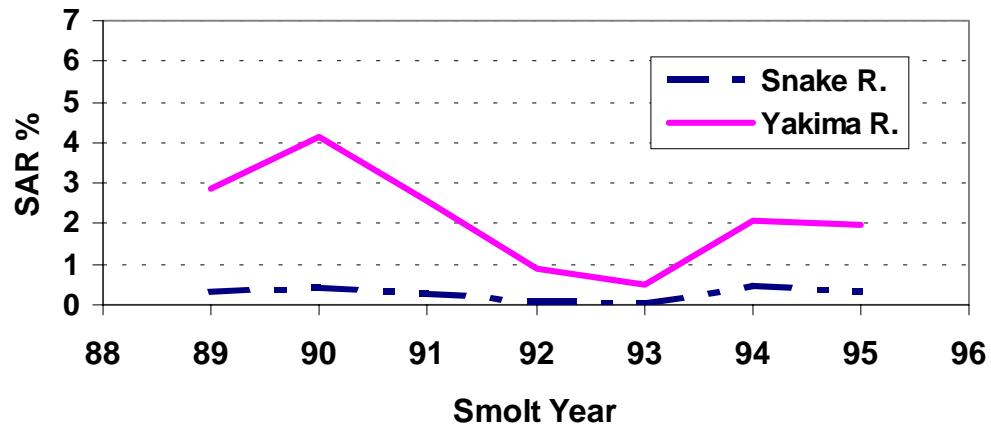
SAR: Yakima R. & Transported Snake R.

Figure 8. Smolt-to-adult return rates (SAR) for Yakima River wild spring chinook and Snake River spring/summer chinook that were transported, smolt years 1989-1995. Yakima stocks migrated past four dams and Snake stocks were barged or trucked past up to 8 dams.
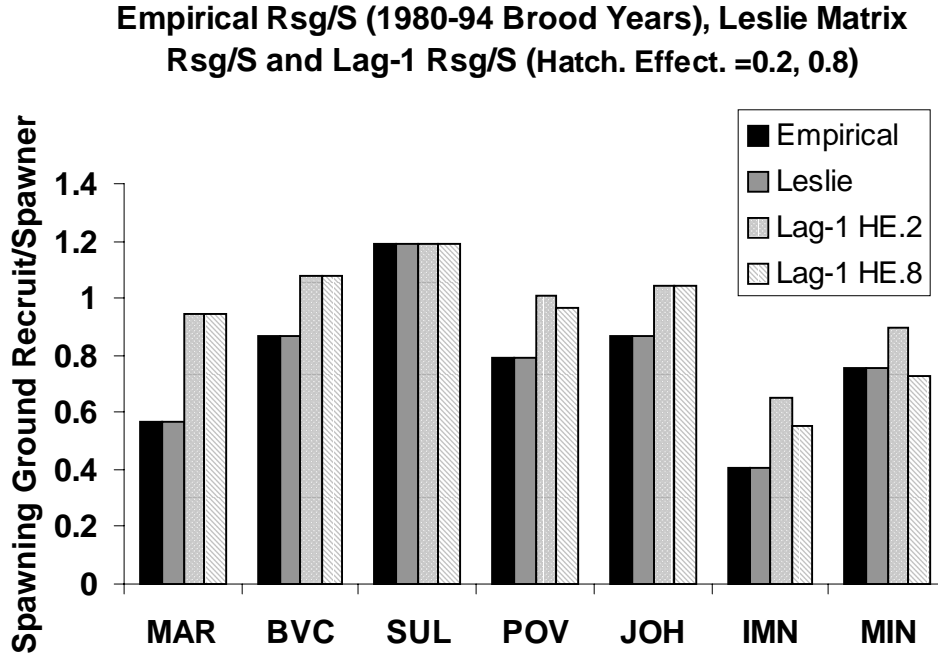
Empirical Rsg/S (1980-94 Brood Years), Leslie Matrix Rsg/S and Lag-1 Rsg/S (Hatch. Effect. =0.2, 0.8)

Figure 9. Empirical estimates of recruits to spawning grounds per spawner (R_{sg}/S) for seven index stocks of Snake River spring/summer chinook, brood years 1980-1994, compared to CRI Leslie matrix estimates, and September 2000 CRI estimates from the updated BiOp. Index stocks are Marsh (MAR), Bear Valley (BVC), Sulphur (SUL), Poverty Flat (POV), Johnson (JOH), Imnaha (IMN), and Minam (MIN). Updated CRI estimates used a one-year lag of spawner numbers (Lag-1) and alternative assumptions about hatchery effectiveness (HE).

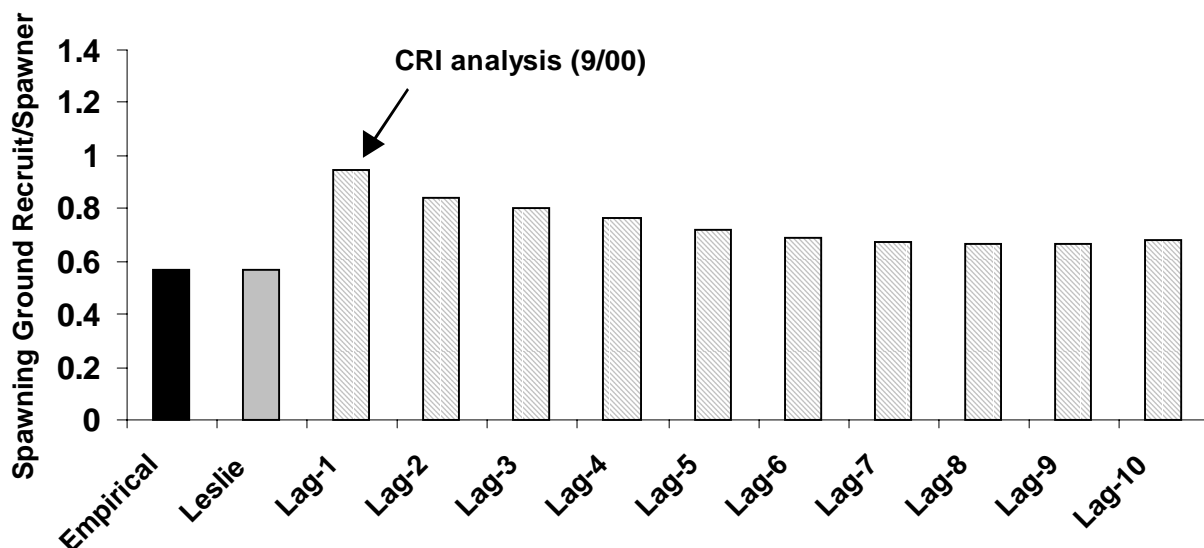**Comparison of Rsg/S for Marsh Creek, Brood Years 1980-94**

Figure 10. Empirical estimate of recruits to spawning grounds per spawner (R_{sg}/S) for the Marsh Creek stock of spring chinook, 1980-1994 brood years, compared to CRI Leslie matrix estimate, one-year lag from the September 2000 CRI approach, and longer lags from the same approach. Lag-2 represents the least squares estimate from lags of 1 and 2 years, Lag-3 from lags of 1 through 3 years, Lag-4 from lags of 1 through 4 years, etc.